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Effect of bio-fertilizers with levels of fertilizer on yield attributes and economic of onion bulb

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Abstract
The experiment was conducted at Horticultural Research Farm, College of Agriculture, RVSKVV, Gwalior (M.P.) during *Rabi* season 2018-19 and 2019-20. The treatments included combination of different bio-fertilizers and RDF. The experiment was laid out in randomized block design (RBD) with 15 treatments replicated thrice. I pooled, application of bio-fertilizer with different dose of fertilizers had significantly enhanced the yield and yield attributes *viz*., maximum equatorial diameter of bulb (6.95 cm), polar diameter of bulb (6.29 cm), fresh yield per plant (56.86 g), yield per plot (22.74 kg), yield per hectare (276.02 qt) and dry weight of bulb (31.49 g) were recorded under treatment T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* + PSB at 30, 60, 90 and 120 days after transplanting, respectively. This treatment, gave significantly higher qualitative yield (379.09 q ha^{-1}) and net returns of (Rs. 3,41,198) as well as maximum B: C ratio of 3:1 keeping the soil fertility sustainable for better yield of successive crop.

Keywords: bio-fertilizers, fertilizers, yield, yield attributes and onion etc.

Introduction
Onion (*Allium cepa* L.) is a bulbous, biennial herb belonging to the family Alliaceae and genus Allium. This is consumed all over the world throughout the year. It is one of the important vegetables and spice crop grown in India and being exported to other countries.
India is second largest producer of onion after China in the world. In India, onion is grown in 1315 thousand hectare area and its production is 21838 thousand MT of onion bulb whereas in Madhya Pradesh, it is grown in 152.8 thousand hectares area and production is 3859.83 thousand MT (NHB, 2017-18). The pungency in the onion bulb is due to a volatile oil known as allyl-propyl-disulphide ($C_6H_{12}S_2$) and the red colour is because of the pigment "anthocyanin" and yellow colour because of "quercetin". The nutritive value of onion varies from variety to variety. Nutritionally, fresh onion contains about 86.6 per cent moisture, 11.6 per cent carbohydrates, 0.2 to 0.5 per cent calcium, 0.05 per cent phosphorus and traces of iron and ascorbic acid (Raj *et al*, 2004) [10]. Bio-fertilizers have recently gained with momentum for affecting the sustainable increase in crop yield under various agro-climatic conditions. Role of biofertilizer on the crop growth and yield was documented by Vijayakumar *et al.* (2000) [18] and Ramakrishnan and Thamizhiniyan (2009) [11].
The Inoculation of PSB bio-fertilizer increases the yield of crops by 10 to 30 per cent. *Azospirillum* inoculation helps the plants to attain better vegetative growth and also in saving inputs of nitrogenous fertilizers by 20-30%. Its application of *Azopirillum* has significant effect on nutrient uptake, which may be helpful for increasing the crop production by way of enhancing the soil fertility. Use of bio-fertilizers not only supplement the nutrients but also improve the efficiency of applied nutrients (Bhati *et al.*, 2018) [2].

Material and Methods
The experiment was carried out in at Horticultural Research Farm, College of Agriculture, RVSKVV, Gwalior (M.P.) in during *Rabi* season 2018-19 and 2019-20. The experimental site is located in the north part of Madhya Pradesh at 26^0 13' North latitude and 74^0 4' East longitudes and altitude of 280 meter above mean sea level. The treatments included combination of different bio-fertilizers and RDF. The experiment was laid out in randomized block design (RBD) with 15 treatments *viz.* T_1 – Control (without fertilizer and biofertilizer), T_2 – 50% RDF, T_3 – 100% RDF, T_4 – *Azospirillum*, T_5 – *Azotobacter*, T_6 – PSB, T_7 – 50% RDF + *Azospirillum*, T_8 – 50% RDF + *Azotobacter*, T_9 – 50% RDF + PSB, T_{10} – 100% RDF + *Azospirillum*, T_{11} – 100% RDF + *Azotobacter*, T_{12} – 100% RDF + PSB, T_{13} – *Azospirillum* +

Azotobacter + PSB, T_{14} – 50% RDF + *Azospirillum* + *Azotobacter* + PSB and T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* + PSB and three replications. The onion variety was used in the experiment "Agri found Light red". About seven week old seedlings having of 12 to 15 cm height were transplanted in evening hours at spacing of 15 x 10 cm in flat beds. The gross plot size was 3 m x 2 m. Randomly, five plants were selected in each plot for data recording.

Result and Discussion

Yield and its attributing parameters

On the basis of two years pooled data, the data present in table 1. The quantitative assessment of crop productivity, growth characters and yield contributing characters influenced the total bulb yield significantly. Integrated nutrient management increases both vegetative growth parameters and yield contributing characters responses increased total bulb yield. A sufficient, well balanced nutrition available during the whole growth period is an important condition for yield and quality of plant products (Alexander, 1986) [1]. Onion requires all the essential mineral elements for harvesting the yield potential. The use of biofertilizers in combinations with inorganic fertilizers and organic manures offers a great opportunity to increase the production of onion.

Table 1: Effect of different biofertilizers and fertilizers doses on yield parameters of onion in pooled (2018-19 &19-20).

Treatment	Equatorial diameter of bulb (cm)	Polar diameter of bulb (cm)	Fresh weight of bulb per plant (g)	Bulb Yield per plot (Kg)	Fresh Bulb yield /ha (qt)	Dry weight per bulb (g)
T_1 – Control	3.42	3.78	31.65	12.66	211.02	13.93
T_2 – 50% RDF	5.11	4.73	39.03	15.61	260.22	18.69
T_3 – 100% RDF	6.01	5.76	48.58	19.43	323.89	25.79
T_4 – *Azospirillum*	4.51	4.29	34.58	13.83	230.56	18.71
T_5 – *Azotobacter*	4.71	4.54	35.78	14.31	238.53	18.05
T_6 – PSB	4.29	4.13	33.94	13.57	226.24	19.05
T_7 – 50% RDF+*Azospirillum*	5.37	5.10	41.90	16.76	279.34	22.68
T_8 – 50% RDF+*Azotobacter*	5.59	5.37	44.24	17.70	294.93	23.22
T_9 – 50% RDF+PSB	5.24	4.94	40.56	16.22	270.38	21.27
T_{10} – 100% RDF+*Azospirillum*	6.56	6.09	53.23	21.29	354.84	29.24
T_{11} – 100% RDF+*Azotobacter*	6.66	6.22	54.97	21.99	366.44	27.96
T_{12} – 100% RDF+PSB	6.23	5.91	51.06	20.42	340.38	29.01
T_{13} – *Azospirillum*+*Azotobacter*+PSB	4.95	4.70	38.03	15.21	253.56	19.14
T_{14} – 50% RDF+*Azospirillum*+*Azotobacter*+PSB	5.74	5.52	46.93	18.77	312.83	24.83
T_{15} – 100% RDF+*Azospirillum*+*Azotobacter*+PSB	6.95	6.29	56.86	22.75	379.09	31.49
SE(m)	0.183	0.140	1.231	0.843	14.042	0.759
CD(5%)	0.516	0.395	3.463	2.370	39.500	2.134

Equatorial diameter of bulb (cm)

Significantly and positive results in pooled analysis, the highest equatorial diameter (6.95 cm) were recorded under the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, closely followed by T_{11} (6.66 cm), T_{10} (6.23 cm) and T_{12} (6.02 cm) at harvesting time. Significantly minimum equatorial diameter (3.42 cm) was noticed under the treatment T_1 - Control at harvesting time. These results are in accordance with the findings of Ranjan *et al.* (2019) [12], Wankhade and Kale (2019) [19], Vachan and Tripathi (2018) [18] and Singh and Ram (2014) [14].

The fact that *Azotobacter* is known to produce antifungal, antibiotic substances that inhibit the activities of various type of soil fungi It can also synthesize and secrete thiamin, riboflavin, pyridoxin, cyanocobalamine, nicotinic acid, pentathenic acid, indole acetic acid and gibberellins or gibberellin like substances resulting in vigorous plant growth and dry matter production which in turn resulted in better fertilization, bulb development and ultimately the higher yield. Similar results have also been reported by Dibut (1993) [4] and Bhonde *et al.* (1997) [3].

Polar diameter of bulb (cm)

The highest polar diameter (6.29 cm) were recorded under the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, closely followed by T_{11} (6.22 cm), T_{10} (6.09 cm) and T_{12} (5.91 cm) at harvesting period. Significantly minimum polar diameter (3.77 cm) was noticed under the treatment T_1 - Control at harvesting period, followed by T6 – PSB (4.12 cm) in pooled. The results are agreement with Wankhade and Kale (2019) [19], Vachan and Tripathi (2018) [18] and Ghanti and Sharangi (2009) [5].

Fresh weight of bulb per plant (g)

Significantly and positive result received in both years, the maximum fresh weight of bulb per plant (56.86 g) was recorded in treatment T_{15}, which was significantly superior to all the remaining treatments except T_{11} (54.96 g), which was at par with it. The treatment T_{10} (53.23 g) was at par with the treatment, T_{12} (51.06 g). However, the lowest fresh weight of bulb per plant (31.65 g) was observed in the treatment T_1 (Control) which was at par with treatments T_6 (33.95 g). The maximum weight of bulb is show that application of inorganic fertilizers with bio-fertilizers gave in experimental field. The investigation results are also collaborated with Rathor *et al.* (2020) [13], Kumar *et al.* (2019) [9], Vanchan and Tripathi (2017) and Singh and Ram (2014) [14].

Bulb yield

The maximum bulb yield per plot (22.74 kg) was recorded in treatment T_{15}, which was significantly superior to all the remaining treatments except T_{11} (21.98 kg), which was at par with it. The treatment T_{10} (21.29 kg) was at par with the treatment, T_{12} (20.42 kg). However, the lowest bulb yield per plot (12.66 kg) was observed in the treatment T_1 (Control) which was at par with treatments T_6 (13.57 kg) in pooled. These results are in close conformity with the findings of Ranjan *et al.* (2019) [12] and Singh *et al.* (2017) [16].

Significantly and positive result received in pooled analysis, the maximum marketable bulb yield (376.02 q ha^{-1}) was recorded in treatment T_{15}, which was significantly superior to

all the remaining treatments except T_{11} (366.24 q ha^{-1}), which was at par with it. The treatment T_{10} (354.84 q ha^{-1}) was at par with the treatment, T_{12} (340.37 q ha^{-1}). However, the lowest marketable bulb yield (211.02 q ha^{-1}) was observed in the treatment T_1 (Control), which was at par with treatments T_6 (226.24 q ha^{-1}). These results are in close agreement with those of Kumar *et al.* (2019) [9], Vanchan and Tripathi (2018) [18], Singh *et al*. (2017) [16] and Singh and Ram (2014) [14].

Onion requires all the essential mineral elements for harnessing the yield potential. Heavy manuring has been recommended for getting good yields of onion by different workers in India. The use of bio-fertilizers in combinations with chemical fertilizers and organic manures offers a great opportunity to increase the production of onion. In onion, combination of organic, inorganic and biofertilizers enhances the bulb yield production with better quality of bulbs (Warade *et al.,* 1995) [20].

Dry weight per bulb (g)

The increase in bulb dry weight can be contributed to increased plant photosynthetic rate achieved by VAM inoculation through increased leaf stomatal conductance as compared to uninoculated plants resulting in more CO2 uptake (Huixing Song, 2005) [7]. K which is an activator of enzymes involved in protein and carbohydrate metabolism plays an important role in the translocation of photosynthates from leaves of bulb which would have been utilized in building up of new cells and tissues leading to increased bulb fresh and dry weight as has been in reported in case of potato by Hans-Eckhard *et al.,* (1973) [6].

The maximum dry weight per bulb (31.49 g) was observed under treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, followed by T_{11} (27.96 g), and other treatments. However, significantly lower value of dry weight per bulb (13.93 g) was recorded in the treatment T_1- Control. These results also correlated with those of Kaur and Singh (2019) [8] and Singh *et al.* (2017) [15].

Economics of the treatments

The data pertaining to economics of all treatment is depicted in Table – 2. It showed that maximum gross income (Rs. 4,54,908), net returns (Rs. 3,41,198) per hectare and B:C ratio of 3.00 were observed for onion bulb production with the application of T_{15} (100% RDF + *Azospirillum* + *Azotobacter* + PSB), followed by gross income (Rs. 4,39,740), net returns (Rs. 3,27,440) and B:C ration (2.92) in the treatment T_{11}, whereas minimum gross income (Rs. 2,53,224), net returns (Rs. 1,50,264) and B:C ration (1.46) were recorded with the treatment T_1 (Control). The higher values of net returns under these treatments could be ascribed to the higher bulb yield of onion obtained under treatment T_{15}. Similar results have been reported by Vachan and Tripathi (2017) [16], Vachan and Tripathi (2018) [18].

Table 2: Economics of the treatments.

Treatment	Bulb yield /ha (qt)	Gross income (Rs./ha)	Cost of cultivation (Rs./ha)	Cost of treatment (Rs./ha)	Total expenditure (Rs./ha)	Net income (Rs./ha)	B:C ratio
T_1 – Control	211.02	2,53,224	1,02,960	0	1,02,960	1,50,264	1.46
T_2 – 50% RDF	260.23	3,12,276	1,02,960	4400	1,07,360	2,04,916	1.91
T_3 – 100% RDF	323.89	3,88,668	1,02,960	8800	1,11,760	2,76,908	2.48
T_4 – *Azospirillum*	230.56	2,76,672	1,02,960	660	1,03,620	1,73,052	1.67
T_5 – *Azotobacter*	238.54	2,86,248	1,02,960	540	1,03,500	1,82,748	1.77
T_6 – PSB	226.25	2,71,500	1,02,960	750	1,03,710	1,67,790	1.62
T_7 – 50% RDF + *Azospirillum*	279.34	3,35,208	1,02,960	5060	1,08,020	2,27,188	2.10
T_8 – 50% RDF + *Azotobacter*	294.94	3,53,928	1,02,960	4940	1,07,900	2,46,028	2.28
T_9 – 50% RDF + PSB	270.38	3,24,456	1,02,960	5150	1,08,110	2,16,346	2.00
T_{10} – 100% RDF + *Azospirillum*	354.84	4,25,808	1,02,960	9460	1,12,420	3,13,388	2.79
T_{11} – 100% RDF + *Azotobacter*	366.45	4,39,740	1,02,960	9340	1,12,300	3,27,440	2.92
T_{12} – 100% RDF + PSB	340.38	4,08,456	1,02,960	9550	1,12,510	2,95,946	2.63
T_{13} – *Azospirillum* + *Azotobacter* + PSB	253.56	3,04,272	1,02,960	1950	1,04,910	1,99,362	1.90
T_{14} – 50% RDF + *Azospirillum* + *Azotobacter* + PSB	312.84	3,75,408	1,02,960	6350	1,09,310	2,66,098	2.43
T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* + PSB	379.09	4,54,908	1,02,960	10750	1,13,710	3,41,198	3.00

Selling of onion = 12/kg

Conclusion

On the basis of two the year experiment, it may be concluded that the best treatment effect of recommended dose of fertilizer with bio-fertilizers application in different treatment combinations had significantly influenced the growth parameters, yield parameters and quality parameters, Out of different 15 treatments, T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* +PSB at all the stages of crop growth had showed its effectiveness on all the parameters studied and given satisfactory outcome. This treatment, gave significantly higher qualitative yield (379.09 q ha^{-1}) and net returns of (Rs. 3,41,198) as well as maximum B: C ratio of 3:1 keeping the soil fertility sustainable for better yield of successive crop.

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